The Beta-Delayed Proton Decay of ^{23}Al

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In 1992 we re-measured the β-delayed proton decay of ^{23}Al [1]. Specially-designed telescopes, [2] each with two gas-ionization ΔE detectors backed with a 300 μm Si E detector, allowed protons with energies as low as ~200 keV to be measured and identified in a high-radiation environment. In addition to the known 832 keV peak [3], new proton groups were observed, with energies of 223 ±20 keV and 560 ±5 keV in the laboratory frame. The former agrees with the expected energy from the isobaric analog state (IAS), 206 keV. The intensities of these peaks were compared to predictions using full-basis (1*s*-0*d* shell) wave functions made by B. A. Brown [4]. The IAS-peak was ~50 ±30 times more intense than predicted by Brown using the isospin-non-conserving interaction of Ormand and Brown [5].

We wished to confirm this unexpected result. A particular concern was that the IAS peak might have been contaminated by events from the β-delayed alpha decay of ^{20}Na; it was found that the ^{16}O recoils from this decay, detected in coincidence with the preceding β particle, could mimic very low-energy protons. To overcome this problem, we have re-measured this decay using two modified detector telescopes that are the same as those used previously, except that a 63 μm Si detector has been added in front of the 300 μm Si detector. This allows rejection of β events.

In the remeasurement, Mg targets were bombarded by 40 MeV protons at the 88" Cyclotron. A He-jet system transported the activity from the target to a counting area ~0.3 m away. The activity was deposited onto the rim of a catcher wheel where it was viewed by the two telescopes. Calibration was performed using ^{25}Si β-delayed protons from the ^{24}Mg(^{3}He,2n)^{25}Si reaction; the calibration was extended down to ~200 keV by *in situ* degradation of these protons using Al foils of known thicknesses [see ref. 2].

Fig. 1 shows the proton spectrum that resulted. As before, three intense proton groups were observed, but the relative intensity of the lowest-energy group was less by a factor of ~7. The re-measured energy for this peak was 245 ±15 keV, placing its origin in question. The energies and intensities of the other two peaks remained the same. Several weaker proton peaks at higher energies were also observed; their intensities are being compared with predictions.

If the 245 keV peak is from the IAS, the isospin mixing for that state will be in much better agreement with Brown's prediction of 0.24%. This state may play a role in the astrophysical rp process, thought to occur in novae. The proton-capture strength ωγ on ^{22}Na, inferred from the measured intensity will also be in better agreement with the limit of 2.6 meV set by Stegmüller *et al.* [6] than our previous value of 45 ±25 meV.

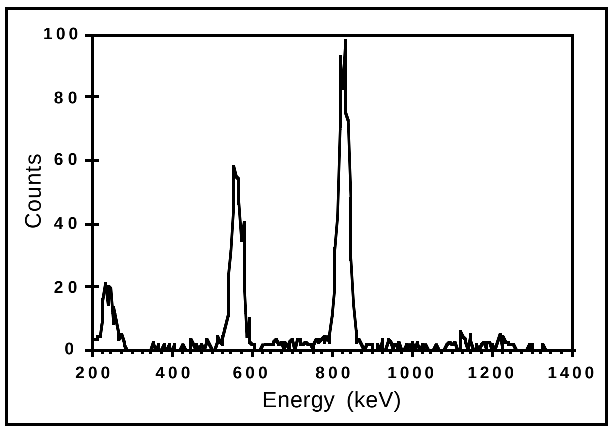

Fig. 1. Beta-delayed protons from ^{23}Al.

Footnotes and References:

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